PROPERTIES AND LIQUEFACTION RISK ON BULK CARGOES CARRYING GEBENG, KUANTAN BAUXITE IN ACCORDANCE TO IMSBC CODE

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I hereby declare that I have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Civil Engineering.

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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To my beloved family.

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ABSTRACT

This research is to identify the differences between the geotechnical properties of raw and processed Gebeng bauxite. Raw bauxite deposits usually contain a higher percentage of clay and siliceous materials. The silica present in the bauxite usually are concentrated in the finer grained fraction of the bauxite deposit. The fine particles in bauxite will cause the bauxite to have higher moisture content and increases the risk of liquefaction to occur during the bauxite's transportation in cargo. The main objective of having beneficiation process before cargo transporting is to minimize the silica content which contributes to the finer fraction in bauxite, as well as to improve the geotechnical properties of bauxite so that it passes the specification of International Maritime Solid Bulk Cargoes Code (IMSBC) for cargo shipping purpose. In this research, a series of laboratory tests will be conducted and the results will reflect the geotechnical properties of Gebeng Bauxite and the correlation of the bauxite's properties can be done. Both the raw and processed Gebeng Bauxite samples will undergo moisture content test, specific gravity test, particle size distribution, Field Emission Scanning Electron Microscope (FESEM) and X-ray fluorescence (XRF) to obtain the desired data.

ABSTRAK

Penyelidikan ini bertujuan untuk mengenal pasti perbezaan antara bauksit Gebeng mentah dan bauksit Gebeng yang telah diproses dari segi sifat-sifat geoteknik. Bauksit mentah biasanya mempunyai peratus tanah liat dan bahan–bahan bersilika yang tinggi. Silika yang berada dalam bauksit biasanya menyumbang kepada zarah halus dalam bauksit. Zarah halus yang berada dalam bauksit akan menyebabkan bauksit mengandungi kandungan kelembapan yang tinggi dan meningkatkan risiko pencairan untuk berlaku ketika dalam pengangkutan kargo. Objektif utama untuk menjalankan proses pembasuhan bauksit sebelum pengangkutan kargo adalah untuk mengurangkan kandungan silika yang menyumbang kepada zarah halus dalam bauksit, dan untuk meningkatkan sifat-sifat geoteknik bauksit supaya ia memenuhi spesifikasi yang ditetapkan dalam Kod IMSBC (Intternational Maritime Solid Bulk Cargoes Code) untuk tujuan pengangkutan kargo. Dalam penyelidikan ini, berbagai ujian makmal akan dijalankan dan keputusan ujian makmal tersebut akan melambangkan sifat-sifat geoteknik untik bauksit Gebeng dan kolerasi untuk sifat-sifat bauksit boleh didapatkan. Kedua-dua bauksit Gebeng mentah dan bauksit Gebeng yang telah diproses akan menjalani ujian kandungan kelembapan, ujian graviti tentu, taburan saiz zarah, Field Emission Scanning Electron Microscope (FESEM) dan X-ray fluorescence (XRF) untuk mendapatkan data yang diingini.

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LIST OF SYMBOLS

°C	Degree Celsius
%	Percentage
km	Kilometer
g	Gram
kg	Kilogram
mm	Milimeter
µm	Micrometer

ABBREVIATIONS

pH	Potential hydrogen
IMSBC	International Maritime Solid Bulk Cargoes
FESEM	Field Emission Scanning Electron Microscope
XRF	X-Ray Fluorescence
Al	Aluminium
Fe	Iron
Na	Sodium
O	Oxygen
Ti	Titanium
Si	Silicon

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF RESEARCH

The third most abundant element that exists in the earth's crust is Aluminium which is after silicon and oxygen. It makes up for about the earth's solid surface's weight by 8% (Schreiner, 2004). Aluminium remained so rare and was not segregated until 1825. It was said to be valued more highly compared to silver. Unlike silver and gold, Aluminium in its pure form is too reactive thus it did not occur in this pure state and that's is the reason that this element remained uncovered for so long. Aluminium can be described as a strong, malleable metal element that has low density and high resistant to corrosion. Besides it highly reflective surface properties, aluminium is a good conductor of heat and electricity. Its corrosion resistance and easy shaping characteristic become a reason to be choose in drink cans and roofing materials industry. Alternatively, Aluminium is found and discovered as bauxite, ore which its colour is reddish-brown. As the end-product of bauxite only being exposed, people tend to recognize aluminium rather than bauxite. Therefore, bauxite mining at the area contribute to anxiety of locals as the mines are located near to residential area.

Bauxite is a mixture of hydrous aluminium oxides, aluminium hydroxides, clay minerals and insoluble materials such as quartz, magnetite, hematite, siderite and goethite. In the industrial perspective point of view, Bauxite is considered as a natural material that which can extract alumina from it in a Bayer plant (Lozej, 1993). The alumina will be extracted from bauxite through the Bayer process, where the ore is mixed with sodium hydroxide and then heat up inside a pressure chamber with temperature of 150 °C to 200 °C until the alumina dissolved and then being filtered out. This process

will create waste by-product which is known as bauxite residue or what we called red mud, a heavy metal laden slurry with high alkalinity which can, contain naturally occurring radionuclides at times (Gore, 2015). Nowadays, the bauxite's mining work had reached a number of 220 million tons per year, with Australia as the leading country that provides almost one-third of total production of Bauxite in the world (Gore, 2015). The world's biggest bauxite producing countries was shown in Figure 1.1

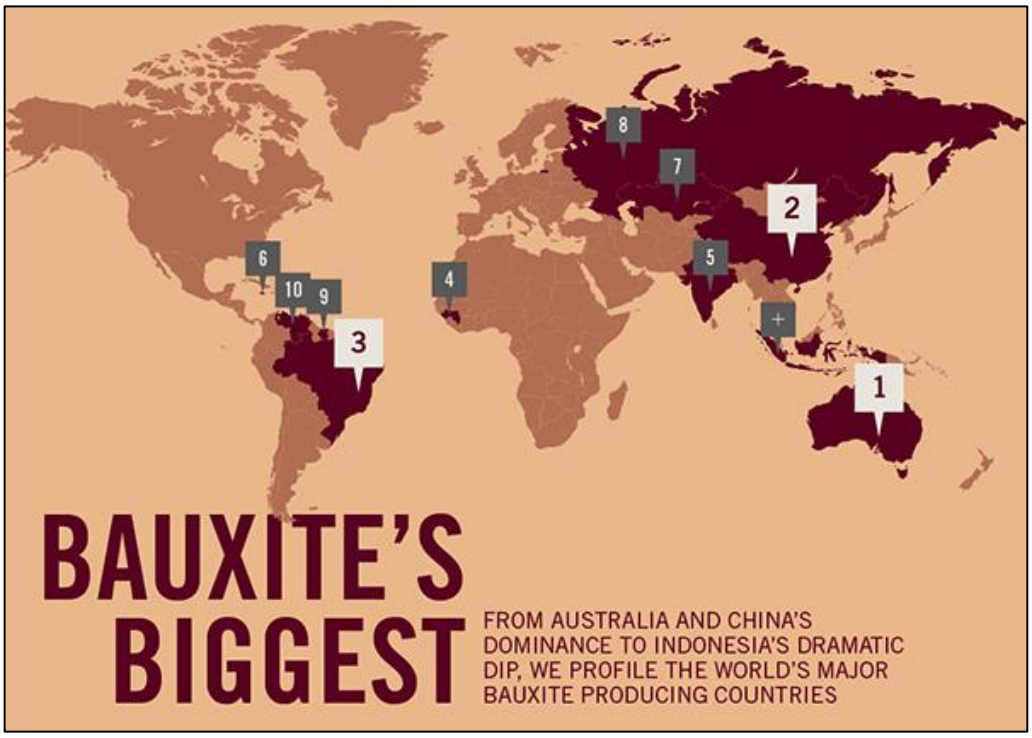

Figure 1.1: Bauxite Producing Countries

Source: Gore (2015)

Bauxite mining has become a contentious issue in Kuantan, Pahang. Since Indonesia stopped producing and exporting bauxite ores to China, Malaysia miners take over the labour and later become the world's top producer beating China itself for nearly half of its ore supply. In 2013, around 100,000 tonnes of bauxite are exported and increased to approximately 205 million tonnes in a year. The exports of bauxites hit a high mark of 20 million tonnes in 2015. The most famous excavation area is Gebeng and Bukit Goh Kuantan, Pahang. Unregulated mining bauxite gives crucial impact to the

serving community. Out of 236 active mine sites, only 36 are legal. This means that, for one legal site excavated, another six are being dug up. Red cuts in the hills are seen behind the east coast town of Kuantan. Based on New Straits Times Online (2015), it was reported that Kuantan, Malaysia is facing severe hazard due to mining of bauxite at that area. A scientist team has sounded warning to public that the damage caused from this poorly and undirected regulated mining activity to our environment may be so intense that the ecosystem might not recover to what it was before. The harmful effect on health of Kuantan's public could be disastrous, and this might carry on for generations. They said, this was in inclusion to the problem of where certain points of water intake being at the downstream of most of the bauxite mines. They underrated the risk that all these hazards might be cause by heavy metals, which includes elements such as mercury, arsenic and aluminium, and also not ignoring other pollutants, which enters the rivers during rain.

1.2 PROBLEM STATEMENT

Exploration of earth resources contribute to national economic growth as it involves international market and demand. Therefore, potential mining location of earth resources is identified such for this study is at Gebeng, Kuantan Pahang. The collected area is at Port Kuantan; approximately 5.7 km from study area. Transportation of bauxite from mine to collective area had resulting a leakage of bauxite fine fraction on the road as well as the surrounding area. It can be said that the area had been polluted by the bauxite residue due to improper method of transport. Hence, the study is done to this area to identify the properties of bauxite due to long term exposure to human and surrounding.

Recently, the loss of Bulk Jupiter – a cargo that carries bauxite from Kuantan, Malaysia to China had risen up the concern of industry and public on bauxite liquefaction. The cargo sunk on a voyage from Kuantan to China which is fully loaded with bauxite and is said to be caused by bauxite liquefaction (Bahamas, 2015). Based on Bahamas Maritime Authority (BMA)'s report on Bulk Jupiter (2015), it highlights on the moisture content of the bauxite transported exceeds the IMSBC specification which is 10%. The testing on cargo loaded on Bulk Jupiter were made and the test revealed that the bauxite

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